MC Simulations of the Hjet

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Ancillary-Polarimetry EICWG Monthly Meeting

September 1, 2021

Introduction

Hadron polarimetry method at the HJet: based on elastic scattering pp->pp events (in the CNI interference region), selected based on tof, E_{dep} and angle of recoil particle

To be understood:

Sources of background

Conditions of tests

Used in MC simulations:

Pythia6, “minimum bias” processes (11, 12, 13, 28, 53, 68, 91, 92, 93, 94, 95), E_{beam} = 255 GeV, 1B events

HjetSim (by Oleg Eyser), based on Geant4, with:

HJet width σ=26 mm

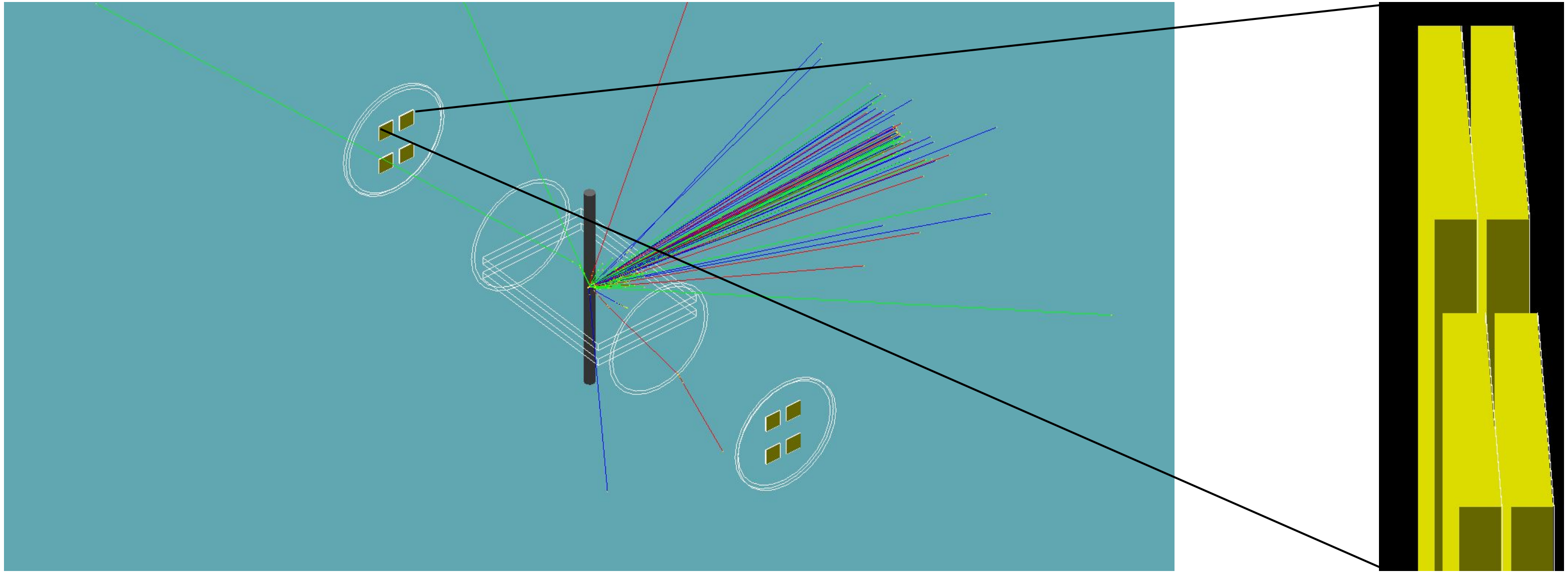
Beam bunches longitudinal extension σ=3.5 ns

Surrounding material: flanges behind the detectors, cylindrical detector chambers, “target chamber”

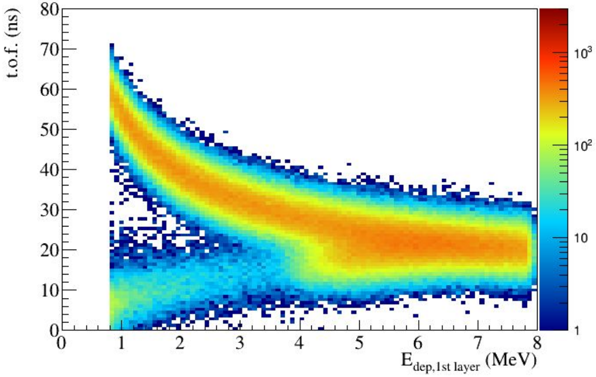
* 2 layers of silicon detectors, w/ dead layers

* W/o and w/ ceramic layer (1.6 mm of alumina)

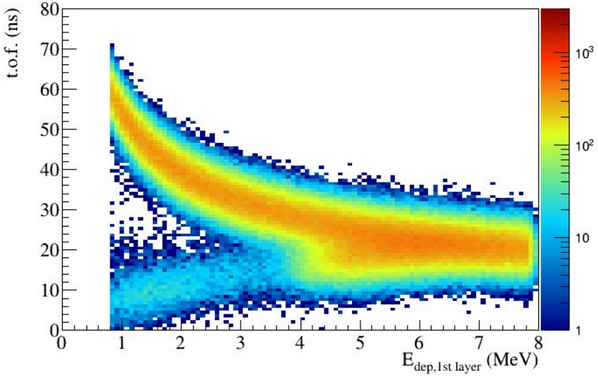
Setup



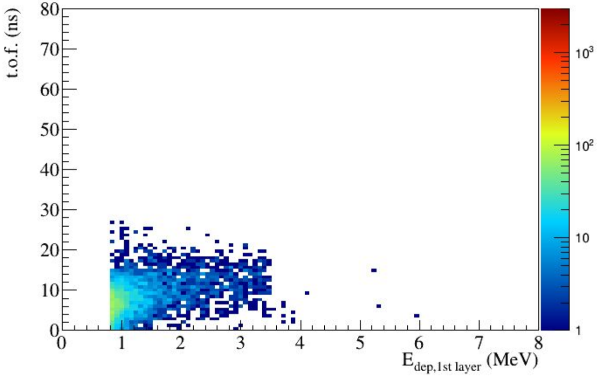
T.o.f. Vs E_{dep}



All particles



Protons

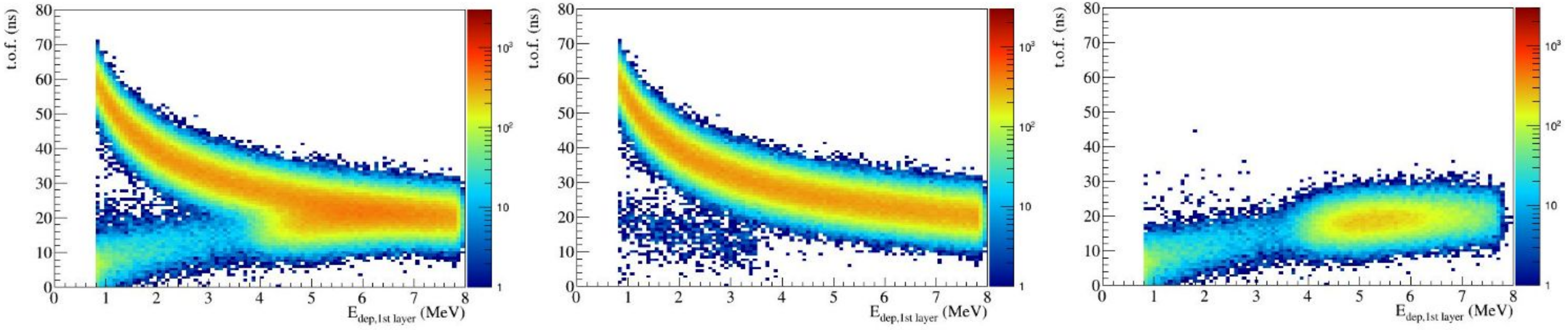


Charged pions

- Punch-through protons and charged pions are identified as sources of background to the elastic event selection

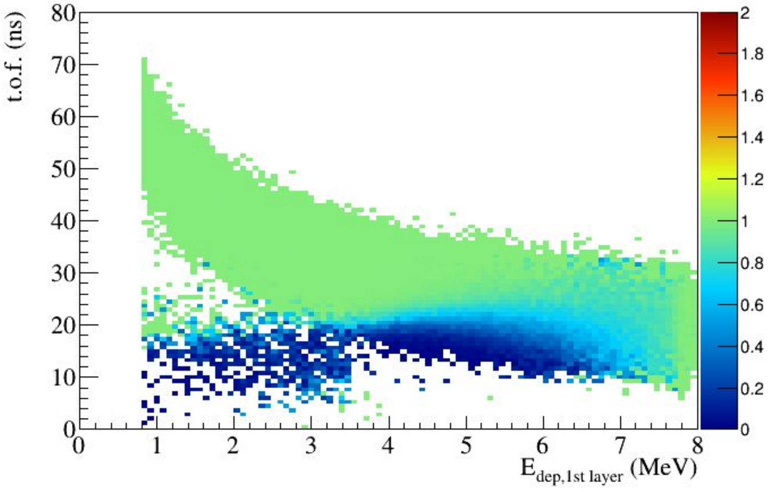
Using second layer to veto background

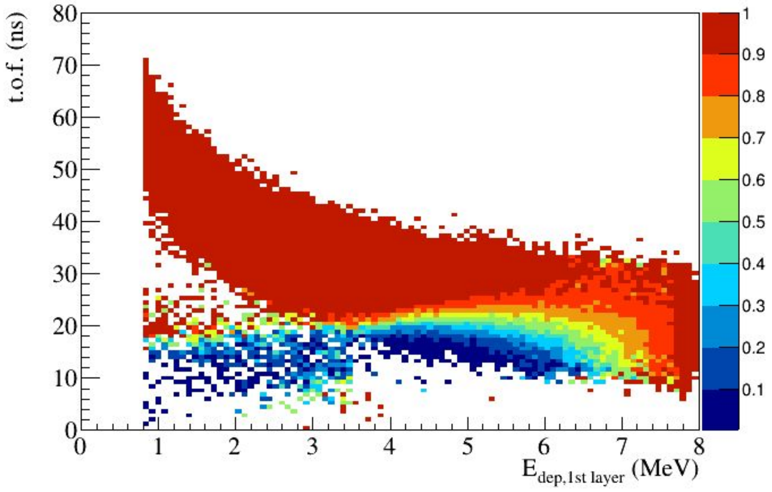
Without ceramic layer



All particles | Particles w/o hits in 2nd layer | Particles w/ hits in second layer

Fraction of particles surviving after veto

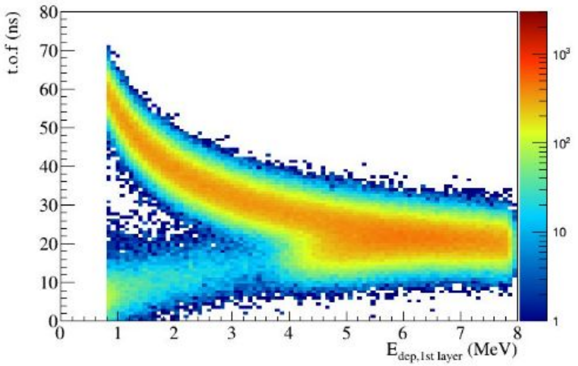




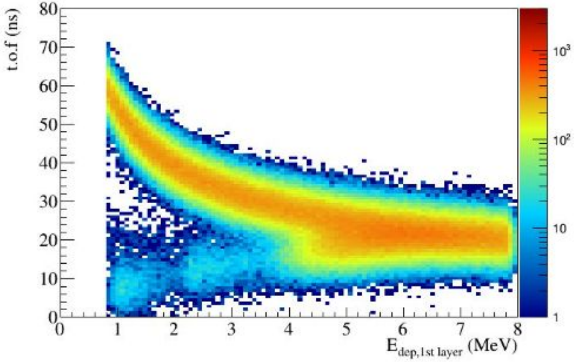
- **Vetoing particles that reach the second Si layer** allows to clean the sample to be used for the polarimetry measurement, by **removing both punch-through protons** and **low t.o.f. and low E_{dep} particles (charged pions)**

Including a ceramic layer in between Si

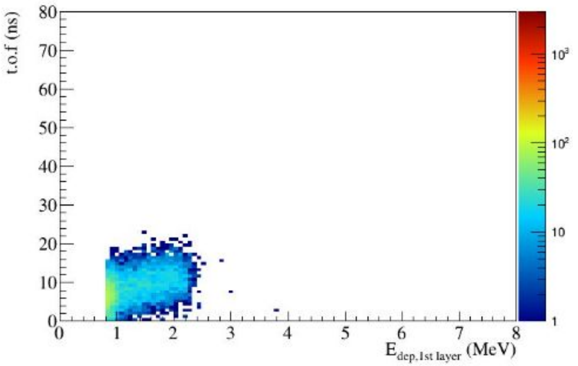
With ceramic layer, 1.6 mm thickness



All particles



Particles w/o hits in 2nd layer



Particles w/ hits in second layer

- The presence of a ceramic layer, as was used in previous tests, limits the particles that reach the second layer of Si, thereby limiting the effectiveness of its use for sample cleanup

Brookhaven National Laboratory

Summary and outlook

The background at low t.o.f. and low E_{dep} is composed of charged pions

A second layer of Si detectors can in principle be used to veto punch-though protons and background charged pions

The presence of a ceramic layer reduced the effectiveness of the veto

Ongoing: study of the impact of a second Si layer in the pC polarimeters

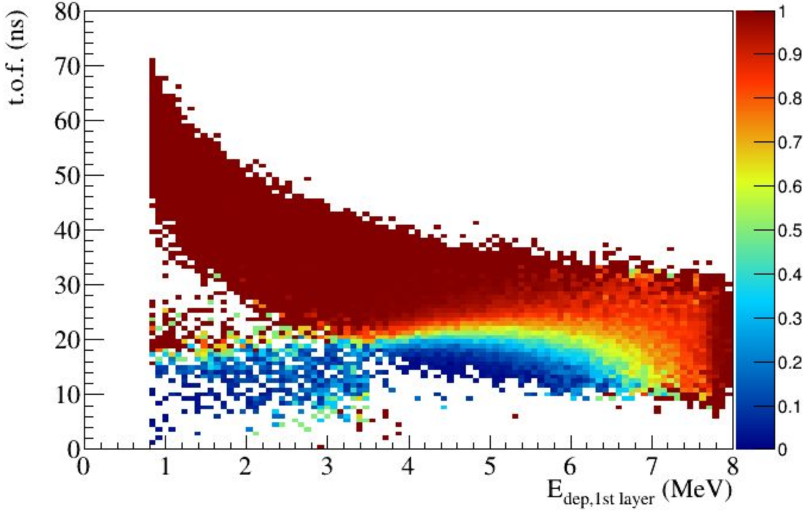
Backup

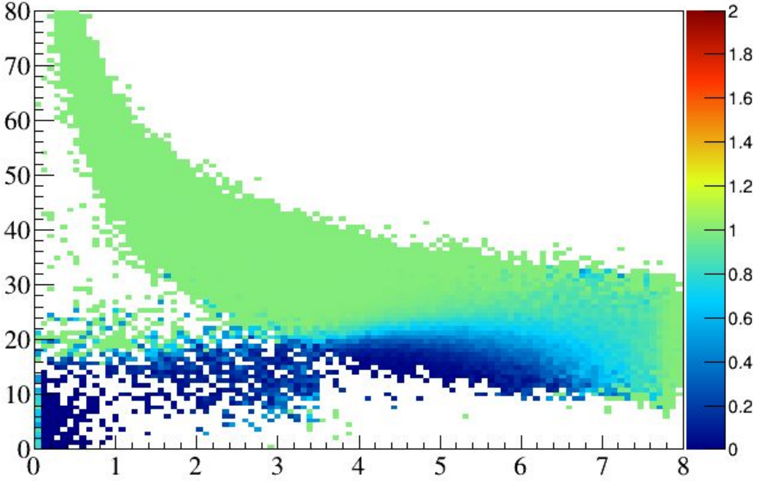
Dimensions of setup elements

```
// flanges behind the detectors

  G4VSolid *flange_tubs = new G4Tubs( "flange_tubs", 0.0, 16.0*cm,
0.5*cm, 0*deg, 360*deg );

  G4LogicalVolume *flange_log = new G4LogicalVolume(
flange_tubs, Steel, "flange", 0, 0, 0 );

  new G4PVPlacement( rot_left,  G4ThreeVector(  78.*cm, 0.0, 0.0),
flange_log, "flange_left",  experimentalHall_log, false, 0 );

  new G4PVPlacement( rot_right, G4ThreeVector( -78.*cm, 0.0, 0.0),
flange_log, "flange_right", experimentalHall_log, false, 0 );


  // cylindrical detector chambers

  G4VSolid *chamber_tubs = new G4Tubs( "chamber_tubs",
15.0*cm, 16.0*cm, 25.0*cm, 0*deg, 360*deg );

  G4LogicalVolume *chamber_log = new G4LogicalVolume(
chamber_tubs, Steel, "chamber", 0, 0, 0 );

  new G4PVPlacement( rot_left,  G4ThreeVector(  52.5*cm, 0.0, 0.0),
chamber_log, "chamber_left",  experimentalHall_log, false, 0 );

  new G4PVPlacement( rot_right, G4ThreeVector( -52.5*cm, 0.0,
0.0), chamber_log, "chamber_right", experimentalHall_log, false, 0 );
```

```
// converter (test)
  // use this as template for the plates of the target chamber
  // (the PYTHIA filter will need to be opened up for particles to hit these
plates)
  G4VSolid *convert_box = new G4Box( "convert_box", 23.*cm, 1.*cm, 16.*cm
);
  G4LogicalVolume *convert_log = new G4LogicalVolume( convert_box, Steel,
"converter", 0, 0, 0 );
  new G4PVPlacement( 0, G4ThreeVector( 0.0,  2.375*cm, 0.0), convert_log,
"converter_left", experimentalHall_log, false, 0 );
  new G4PVPlacement( 0, G4ThreeVector( 0.0, -2.375*cm, 0.0), convert_log,
"converter_right", experimentalHall_log, false, 0 );

  // From https://doi.org/10.1016/j.nima.2020.164261
  G4double DSi = 77*cm; //cm
  G4double dSi = 0.047*cm; //cm
  G4double dSiOver2 = dSi*0.5; //cm
  G4double space = 0.001*cm; // to avoid superpositions
  G4double littlespace = 0.0001*cm; // to avoid superpositions
  G4double dSiDead = 0.000159*cm; //cm
  G4double dSiDeadOver2 = dSiDead*0.5; //cm
  G4double dCeramic = 0.16*cm; //cm
  G4double dCeramicOver2 = dCeramic*0.5; //cm
```

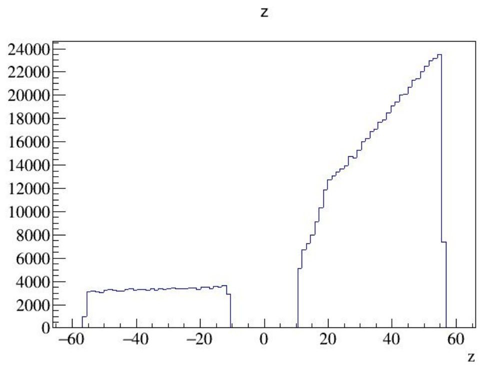
Impact of vetoing



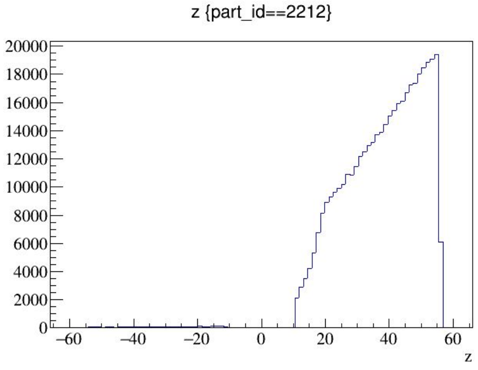


(different formats)

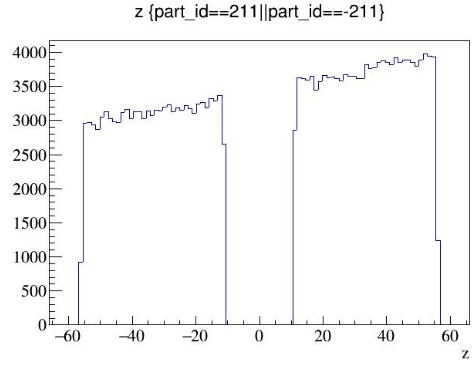
Hits z distributions



All particles



Protons



Charged pions